

STATUS AND RESULTS FROM THE RAVE SURVEY

A. Siebert¹ and the RAVE collaboration

Abstract. RAVE, the RAdial Velocity Experiment, is a large spectroscopic survey which collects spectroscopic data for stars in the southern hemisphere. RAVE uses the AAO Schmidt telescope with a wavelength coverage similar to Gaia but a lower resolution of $R=7,500$. Since 2003, RAVE collected over 500,000 spectra providing an unprecedented dataset to study the structure and kinematics of the Milky Way and its stellar populations. In this review, we will summarize the main results obtained using the RAVE catalogues.

Keywords: Surveys, Stars: kinematics and dynamics, Galaxy: general, Galaxy: stellar content, Galaxy: structure

1 The RAdial Velocity Experiment: overview and current status

Understanding the formation and evolution of galaxies is one of the main challenge of present day astronomy, and due to our location in its disc, the Milky Way offers a large amount of possibility to gain detailed insights on this subject. Progress on this topic more and more relies on the measurement of the six dimensions of the phase-space, positions and velocities, and the measurement of precise chemical abundances for stars in the Galaxy. The measurement of six dimensional phase-space requires the knowledge of the generally missing line-of-sight (LOS) velocity which is the primary goal of RAVE.

Taking advantage of multi-object spectroscopy which enables to acquire spectra for multiple stars simultaneously, RAVE started its observations in 2003. RAVE uses the 6dF instrument mounted on the Schmidt telescope of the AAO in Siding Spring, Australia. This instrument enables us to collect spectra for up to 150 stars in a 5.8 degrees in diameter field with a single observation. The targeted spectral region, $\lambda\lambda 8410 - 8794$, contains the infrared Calcium triplet and is similar to the wavelength domain chosen for Gaia. The effective resolution of $R \sim 7,500$ enables us to measure radial velocities with a precision better than 5 km s^{-1} , the mode of the distribution being better than 2 km s^{-1} . As of July 2012, RAVE collected more than 556,000 spectra for more than 468,000 individual stars. The distribution on the sky of the observed RAVE targets, as of June 2010, is shown in Fig. 1 and covers a large fraction of the sky accessible from the southern hemisphere.

So far, RAVE radial velocities and associated measurements have been released to the community in three data releases: DR1 (Steinmetz et al. 2006) provided LOS velocities for 25,000 stars covering 4,700 square degrees in the southern hemisphere, DR2 (Zwitter et al. 2008) released $\sim 82,000$ LOS velocities and estimates of the atmospheric parameters for $\sim 21,000$ stars while DR3 (Siebert et al. 2011b) expended these numbers to 80,000 LOS velocities and atmospheric parameters for 40,000 stars. These catalogues are supplemented by catalogues providing distance estimates based on RAVE observations (Breddels et al. 2010; Zwitter et al. 2010; Burnett et al. 2011) which enable to estimate the six dimensional phase-space data of the targets and are also supplemented by a catalogue of chemical abundances by Boeche et al. (2011).

The three first data releases are based on an input catalog build using Tycho-2 and the Supercosmos Sky Survey (SSS). The next data release, DR4 (Kordopatis et al., in prep.), will release data using a new input catalogue based on DENIS I-band magnitudes and will provide improved atmospheric parameters using the DEGAS and MATISSE algorithms (Kordopatis et al. 2011; Bijaoui et al. 2012; Recio-Blanco et al. 2006).

In the next section we will review the contribution of RAVE to the study of the Milky Way and its stellar populations.

¹ Observatoire Astronomique, Université de Strasbourg, CNRS, 11 rue de l'université, 67000 Strasbourg, France

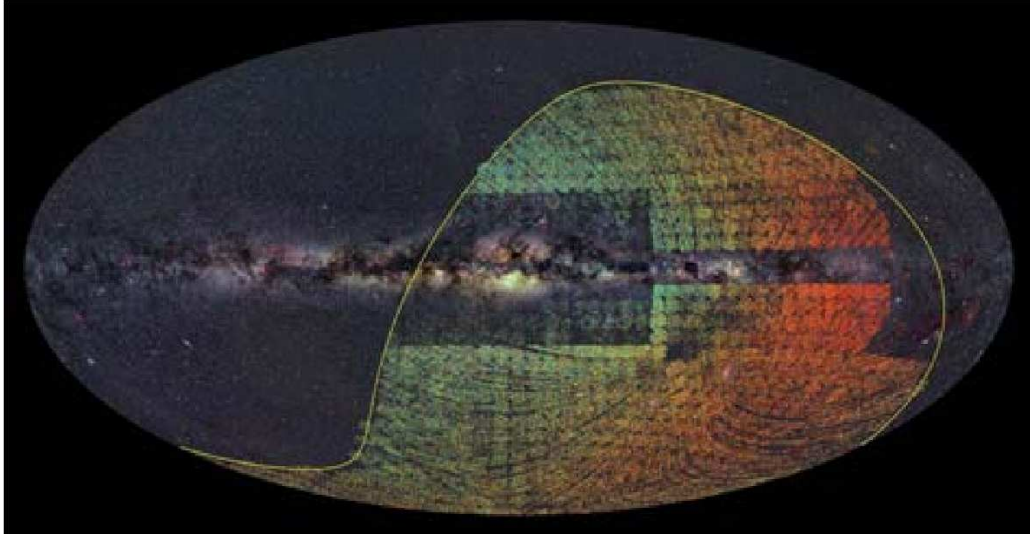


Fig. 1. Aitoff projection of the RAVE targets measured as of June 2010. The yellow line marks the location of the celestial equator. The colour follows the heliocentric line-of-sight velocity, red indicating a velocity larger than 50 km s^{-1} , blue lower than -50 km s^{-1} . The apparent dipole reflects the motion of the Sun with respect to the local standard of rest.

2 Scientific contribution of RAVE

The depth and spatial coverage of the RAVE survey makes it a well suited tool to study the structure and stellar populations of the Milky Way. Indeed, the bulk of RAVE stars samples the Galaxy at distances intermediate between Hipparcos (the solar neighbourhood) and the galactic halo which is well covered by the SDSS. Although RAVE was designed to search for the signatures of the hierarchical build-up of the Milky Way, its design and coverage proved to be useful to study many aspects of the Galaxy. Indeed, this region, between 0.5 and 2 kpc from the Sun, is dominated by the thin disc with an increased contribution of the thick disc. In the following presentation of RAVE results we will try to group the results according to some general topics: structure and kinematics of the Milky Way, origin of the thin and thick discs, moving groups, accretion events and peculiar objects.

2.1 Structure and kinematics

The first RAVE catalogue was released in 2006 and the first scientific result using the RAVE data followed shortly after with a new determination of the local escape velocity of the Milky Way by Smith et al. (2007). Their findings of $v_{esc} = 544 \text{ km s}^{-1}$ ($498 < v_{esc} < 608 \text{ km s}^{-1}$ at the 90 per cent confidence level), based on a sample of high-velocity stars from RAVE combined to previously published data, demonstrates the presence of a dark halo in the Milky Way. Furthermore, assuming a contracted NFW halo model, this result implied a virial mass of $1.42^{+1.14}_{-0.54} 10^{12} M_{\odot}$, significantly higher than previous estimates.

Then Siebert et al. (2008), using a sub-sample of red clump giants whose distance can be estimated from the photometry alone, measured the inclination of the velocity ellipsoid at 1 kpc below the Galactic plane. This inclination, or tilt, is directly linked to the shape of the Galactic potential and of the dark halo. This measurement (7.3 degrees) was compared to predictions varying the flattening of the dark halo and using the latest mass models of the Milky Way by Binney & Tremaine (2008). Although no model could be clearly ruled out, a nearly spherical halo at the Sun's distance from the Galactic center is preferred. This also implies the scale length of the disc to be in the range 2.5-2.7 kpc.

Focusing on the disc, its vertical structure was studied by Veltz et al. (2008). In this work, the authors combined a subsample of RAVE G and K type stars towards the Galactic pole to 2MASS stars counts and UCAC2 proper motions. They were able to identify discontinuities in the kinematic and magnitude counts, discontinuities that separate the different stellar components. The clear kinematic gap between the thin and thick disc reinforced the view that the thick disc is unlikely to have formed from the thin disc in a continuous process. This work also provided new measurements of the scale heights of the thin and thick disc, the thin disc

scale height being measured to be 225 ± 10 pc, and 1048 ± 36 pc for the thick disc.

Casetti-Dinescu et al. (2011) combined a sub sample of 4400 red clump giants from the RAVE DR2 catalogue with the SPM4 (Girard et al. 2011) proper motions to analyse the three-dimensional kinematics of the thick disc population. This sample covers distances from 5 to 10 kpc from the Galactic center and reaches 3 kpc in height from the Galactic plane. They determined the global kinematic parameters of the thick disc to be $(\sigma_{V_R}, \sigma_V, \sigma_{V_z})|_{z=1} = (70.4, 48.0, 36.2) \pm (4.1, 8.3, 4.0) \text{ km s}^{-1}$, with a tilt angle of 8 degrees. This latter value is in agreement with the determination by Siebert et al. (2008) and implies a disc scale length of 2 kpc.

Also, for a good understanding of the Milky Way, a precise knowledge of the Sun velocity vector with respect to the local standard of rest is important. This problem was studied by Veltz et al. (2008) using his model of the vertical structure of the Galactic disc and by Coşkunoğlu et al. (2011). This latter work uses a sub-sample of RAVE stars restricted to 600 pc from the Sun, based on the photometric and spectroscopic properties of the stars. Their findings are in good agreement with recent determinations (see table 1 of Coşkunoğlu et al. 2011, for a summary).

If star counts and velocity distributions are useful to decipher the global properties of the Milky Way, detailed measurements of the structure and kinematics of the stellar populations need the knowledge of the distance. Distances not only allow us to recover the full velocity vector of a star, they also allow us to sample different regions of the Galaxy (Siebert et al. 2008; Casetti-Dinescu et al. 2011, see for example). If red clump stars have proved to be a precious tool for such investigations, they represent only a small fraction of the RAVE catalogues. Thanks to the estimates of stellar atmospheric parameters, spectrophotometric distances could be computed for most of the RAVE stars by three different groups (Breddels et al. 2010; Zwitter et al. 2010; Burnett et al. 2011) with an overall very good agreement between the groups while the techniques rely on different assumptions.

The availability of distances allow a more detailed analysis of the fine structures in the disc but also allows to reduce the uncertainties on the global parameters. For example, Karataş & Klement (2012) revised the thin and thick discs velocity ellipsoid measurements using the Breddels et al. (2010) distances and found an overall good agreement with previous determinations. Siebert et al. (2011a) used the Zwitter et al. (2010) distance estimates to study the mean velocity field in the Galactic plane within 2 kpc from the Sun. They found a radial velocity gradient whose origin lies presumably in non-axisymmetric perturbations of the disc. Assuming the local disc is mostly perturbed by spiral arms, Siebert et al. (2012) used the density wave model to model the observed velocity field and constrain the parameters describing the local spiral pattern. Provided the spiral arms are long-lived, the density wave model with a 2 armed spiral perturbation successfully reproduces the observed velocity gradients and Siebert et al. (2012) estimate the amplitude of the perturbation to be 0.55% of the background potential, having a pattern speed of 18.6 km s^{-1} . This places the Sun close to the inner 4:1 resonance, a location also suggested by the location of moving groups in the solar neighbourhood (Quillen & Minchev 2005, see for example).

2.2 Origin and evolution of the thin and thick discs

The origin and evolution of the Galactic discs are key elements in understanding the formation of the Milky Way. This information about the origin is buried both in the kinematics and in the chemical composition of the stars, such as metallicity gradients or eccentricity distributions, both being available via data provided in the RAVE catalogues.

Focusing on the thick disc chemical properties, Ruchti et al. (2010) selected a sample of 234 metal poor giants in the RAVE catalogue for a follow-up study using high-resolution spectroscopy. A detailed abundance analysis of four α elements and iron abundances revealed an enhancement of the $[\alpha/\text{Fe}]$ ratios as well as a lack of scatter of these ratios. This implies an enrichment that proceeded by purely core-collapse supernovae as well as a good mixing of the interstellar medium (ISM) prior to star formation. Also the ratios indicate a similar massive star initial mass function of the metal poor thick disc and of the halo. This leads the authors to conclude that direct accretion of a dwarf galaxy with similar properties than the surviving dwarf galaxies today did not play an important role in the formation of the thick disc population.

Ruchti et al. (2011a) furthered this work adding 74 main sequence stars to their sample of giant stars and confirmed their previous result. In addition they could investigate for the first time the gradient in α -enhancement in the metal poor thick disc, finding a very shallow gradient ($\frac{\partial[\alpha/\text{Fe}]}{\partial R, z} < 0.03 \pm 0.02 \text{ dex kpc}^{-1}$ for $[\text{Fe}/\text{H}] < -1.2 \text{ dex}$) while they find a $+0.01 \pm 0.04 \text{ dex kpc}^{-1}$ radial gradient and a $-0.09 \pm 0.05 \text{ dex kpc}^{-1}$ vertical

gradient in iron abundance. This further indicates a good mixing of the ISM prior to star formation for this population.

The previous work focused on the properties of the metal-poor thick disc, similar studies used thin disc stars to constrain the observed metallicity gradient using the RAVE catalogue (Karataş & Klement 2012; Coşkunoğlu et al. 2012; Bilir et al. 2012) with values for the radial gradient ranging from -0.04 to $-0.07 \text{ dex kpc}^{-1}$. Also, a dependence with age, older populations showing a shallower radial gradient is observed. The comparison to models of the formation of the Galactic disc suggests a contribution from stellar migration in the shaping of the disc.

Another aspect of the disc formation relies on the distribution of eccentricities. As shown by Sales et al. (2009), different scenarios of the thick disc formation leave different signatures in the distribution of eccentricities of disc stars. This signature has been investigated by different groups using the RAVE data: Casetti-Dinescu et al. (2011) used red clump stars from the DR2, Karataş & Klement (2012) did the same exercise using the DR2 sample together with Breddels et al. (2010) distances and Wilson et al. (2011) used the full RAVE sample. All studies favour an in-situ formation of the thick disc, the direct accretion scenario being in apparent contradiction with the observed distributions. The good agreement with the result based on chemical abundances and metallicity gradients further confirms the in-situ origin of the thick disc.

2.3 Moving groups

Since their discovery (Eggen 1958, 1960), moving groups have been the subject of many studies. If some of the moving groups can be associated to disrupted clusters, some of them are of resonant origin and it is now well established that the location in velocity space of these resonant structures bear useful informations on the perturbations taking place in the Galactic disc.

A first attempt to study the moving groups using the RAVE DR1 data was done by Klement et al. (2008) and continued in a later work using the DR2 catalogue (Klement et al. 2011). In these works, the authors identified four phase-space overdensities, three of which were previously known. The new stream candidate is on a radial orbit, suggesting an origin external to the Milky Way. However, their later work using DR2 data showed that only five stars belong to that overdensity, preventing clear conclusions to be drawn at this point on the origin of this overdensity.

Kiss et al. (2011) searched the RAVE database for new members of young nearby moving groups, combining the RAVE data to stellar age diagnostics and high-resolution optical spectroscopy follow-up. They were able to find one new and five likely members of the β Pictoris moving group, one likely member of the ϵ Cha group and two stars in the Tucana-Horologium association, showing the potential of RAVE to increase the census of young moving groups in the solar neighbourhood.

Hahn et al. (2011) combined data from RAVE and the Sloan Digital Sky Survey to extract a sample of stars within 200 pc of the Sun. They showed that the velocity space structures seen in the Hipparcos sample are also present in these data. They also could associate the Hyades stream to scattering process at a Lindblad resonance, indicating a resonant origin for this feature.

Thanks to the distance estimates mentioned above, it is possible to reconstruct the six-dimensional phase space information and study the evolution of the moving groups beyond the solar neighbourhood. Antoja et al. (2012) used the full RAVE sample together with distances and used a wavelet analysis to detect the moving groups. They showed that the main groups observed in the solar neighbourhood are large scale features, surviving at least 1 kpc from the Sun in the anti-rotation direction and below the Galactic plane. Furthermore, the location of these structures appears to shift in the velocity plane as one moves away from the Sun's location. These trends are consistent with dynamical models of the effects of the bar and spiral arms, again indicating a resonant origin of some of the moving groups.

2.4 Signature of accretion events

One of the main driver of the RAVE survey is the search for signatures of the hierarchical build-up of the Milky Way. Although most of the accretion events are observed in the distant halo (see for example Belokurov et al. 2006), some are believed to leave traces in the inner parts of galaxies including galactic discs. Indeed, the early simulations of the disruption of the Sagittarius dwarf galaxy predicted that the Sagittarius stream could cross the solar neighbourhood. Such an orbit would leave an asymmetry in the radial velocity distributions

between the northern and southern hemisphere. Seabroke et al. (2008) analysed the RAVE data in a cylinder across the disc centered on the Sun and combined this sample to the local surveys from the Hipparcos satellite (Holmberg et al. 2007; Famaey et al. 2005). The symmetry of the velocity distributions permits to rule out the presence of the Sagittarius stream or the Virgo overdensity in the solar neighbourhood. Later simulations of the disruption of the Sagittarius dwarf galaxy showed that the stream does not cross the solar neighbourhood, intersecting the Galactic plane further out from the Sun's location, confirming this result.

More recently, Williams et al. (2011) detected an overdensity of stars, the Aquarius stream, in $30^\circ < \ell < 75^\circ$ and $-70^\circ < b < -50^\circ$, with heliocentric line-of-sight velocities $V_{los} \sim -200 \text{ km s}^{-1}$. These stars are clear outliers in the radial velocity distribution and the overdensity is statistically significant. Analysis of the RAVE stars suggest a metal poor, 10 Gyr old population. Using numerical simulations, they showed that this stream is dynamically young and therefore a debris of either a recently disrupted dwarf galaxy or globular cluster. High resolution follow-up spectroscopy of the overdensity members by Wylie-de Boer et al. (2012) showed very little dispersion in metallicity (0.1 dex) indicating a chemically coherent structure. The location in the nitrogen and sodium abundances plane further indicates that the Aquarius stream originates from a disrupted globular cluster.

2.5 Peculiar objects

The observing strategy of RAVE, a random sampling in magnitude intervals and no colour selection to mimic a magnitude limited survey, enables RAVE to be unbiased with respect to kinematic selection effects. If this strategy is well suited to the main goals of RAVE, it also preserves the discovery potential of RAVE.

Munari et al. (2009) paper is a good example of this discovery potential. Mining the database, the authors discovered stars in the multi epoch spectra of RAVE whose radial velocities and spectra appear dubious for normal Milky Way objects. These stars do not belong to the Milky Way but are Luminous Blue Variable stars (LBV) part of the Large Magellanic Cloud (LMC). Additional specific follow-up exposures were then taken one year apart for seven LBVs, including fainter known LBVs, to obtain a fairly complete sample of LBVs in the LMC. Thanks to the multi epoch spectra, the wind outflow and variability could be investigated in some cases and even cool companions could be detected.

Ruchti et al. (2011b) identified five lithium rich field giants in his metal poor sample of RAVE stars, RAVE being quite rich in metal poor stars as shown by Fulbright et al. (2010). This represents the largest sample of Li-rich giants to date, these objects being rare and important to understand the structure and physical processes taking place in stellar interior. A detailed investigation of the chemical abundances by the authors suggests that Lithium enrichment in these stars is due to cool bottom processing, a different mechanism than the one taking place at the RGB bump.

Among peculiar objects, binary stars are not uncommon and the knowledge of the fraction of stars in binary or multiple systems is an important input of Galactic models. In this respect, identifying multiple stars in the RAVE database is important. Using a method relying on the properties and shape of the cross-correlation function, Matijević et al. (2010) were able to identify 123 double-lined binary candidates (SB2) in the second data release of RAVE, only eight of which were previously known as binary stars in Simbad. This method is sensitive to systems with orbital periods of 1 day up to 1 year. In a following paper, Matijević et al. (2011) used repeated observations of RAVE stars to identify single-lined binary candidates (SB1). In this sample of ~ 20000 stars observed more than once, about 10 to 15% of the stars are detected as binaries. Because of the time span between observations, the detection is biased towards short periods (days to weeks). Therefore the binary fraction reported is a lower limit to the true binary fraction which is the important quantity for Galactic models.

If the analysis of the cross-correlation functions and of the re-observations are efficient tools to detect binary stars, automated classification of RAVE spectra shows a remarkable ability to detect peculiar objects. Matijević et al. (2012) used a local linear embedding technique (LLE) to automatically classify 350,000 RAVE spectra. If 90 to 95% of the spectra belong to normal single stars, there is a significant fraction of peculiar stars populated by the different types of spectroscopic binaries, chromospherically active stars (both of them containing several thousand spectra) or other peculiar objects. Among these peculiar objects one can note TiO band stars, carbon stars, Wolf-Rayet stars, Be stars etc. This shows the large potential of RAVE to increase the statistics and further the understanding of these rare objects.

Finally, if RAVE observing strategy away from the Galactic plane is meant to reproduce the characteristics of a magnitude limited sample, some fields were observed in the Galactic plane for calibration purpose or specific

projects. The study of Diffuse Interstellar Bands (DIB) falls in this last category. Munari et al. (2008) investigated the behaviour of five DIBs in the RAVE spectra. They could confirm the presence of a DIB at 8648\AA whose intensity appears unrelated to reddening. The two DIB at 8531\AA and 8572\AA appear to be artifacts due to blends of underlying stellar lines while the DIB at 8439\AA could not be resolved due to the strong underlying Paschen line. However the DIB at 8620\AA appears strong and clean in the RAVE spectra and turns out to be a reliable estimator of reddening.

3 Conclusions

RAVE operations started in 2003 and collected over half a million spectra since its first light. So far data were released to the public in three data releases and complemented by catalogues containing distance estimates and chemical abundances. The fourth data release is scheduled in late 2012/early 2013.

If RAVE primary goal is to search for traces of the hierarchical build-up of the Milky Way, the design of the survey does not restrict the scientific capabilities of the survey. Indeed, RAVE observations contributed to many topics in Galactic astronomy and provided useful measurements and results that can be grouped in five general topics:

- structure and kinematics of the Milky Way and stellar populations,
- formation and evolution of the Galactic discs,
- velocity space substructures or moving groups,
- signature of accretion events,
- search for peculiar objects.

If the data collection is close to completion, the vast amount of information buried in the RAVE catalogues and spectra still has a large potential for being used by the community. In this respect comparison to models of the Galaxy, such as the Besançon model (Robin et al. 2003) or the Galaxia model (Sharma et al. 2011), will be useful to interpret the RAVE data. This makes RAVE one of the major tools for understanding our Galaxy until the release of the Gaia catalogue.

Funding for RAVE has been provided by: the Australian Astronomical Observatory; the Leibniz-Institut fuer Astrophysik Potsdam (AIP); the Australian National University; the Australian Research Council; the French National Research Agency; the German Research Foundation (SPP 1177 and SFB 881); the European Research Council (ERC-StG 240271 Galactica); the Istituto Nazionale di Astrofisica at Padova; The Johns Hopkins University; the National Science Foundation of the USA (AST-0908326); the W. M. Keck foundation; the Macquarie University; the Netherlands Research School for Astronomy; the Natural Sciences and Engineering Research Council of Canada; the Slovenian Research Agency; the Swiss National Science Foundation; the Science & Technology Facilities Council of the UK; Opticon; Strasbourg Observatory; and the Universities of Groningen, Heidelberg and Sydney. The RAVE web site is at <http://www.rave-survey.org>

References

- Antoja, T., Helmi, A., Bienayme, O., et al. 2012, MNRAS, L499
- Belokurov, V., Zucker, D. B., Evans, N. W., et al. 2006, ApJ, 642, L137
- Bijaoui, A., Recio-Blanco, A., de Laverny, P., & Ordenovic, C. 2012, Statistical methodology, 9, 55
- Bilir, S., Karaali, S., Ak, S., et al. 2012, MNRAS, 421, 3362
- Binney, J. & Tremaine, S. 2008, Galactic Dynamics: Second Edition (Princeton University Press)
- Boeche, C., Siebert, A., Williams, M., et al. 2011, AJ, 142, 193
- Breddels, M. A., Smith, M. C., Helmi, A., et al. 2010, A&A, 511, A90
- Burnett, B., Binney, J., Sharma, S., et al. 2011, A&A, 532, A113
- Casetti-Dinescu, D. I., Girard, T. M., Korchagin, V. I., & van Altena, W. F. 2011, ApJ, 728, 7
- Coşkunoğlu, B., Ak, S., Bilir, S., et al. 2012, MNRAS, 419, 2844
- Coşkunoğlu, B., Ak, S., Bilir, S., et al. 2011, MNRAS, 412, 1237
- Eggen, O. J. 1958, MNRAS, 118, 65

- Eggen, O. J. 1960, MNRAS, 120, 563
- Famaey, B., Jorissen, A., Luri, X., et al. 2005, A&A, 430, 165
- Fulbright, J. P., Wyse, R. F. G., Ruchti, G. R., et al. 2010, ApJ, 724, L104
- Girard, T. M., van Altena, W. F., Zacharias, N., et al. 2011, AJ, 142, 15
- Hahn, C. H., Sellwood, J. A., & Pryor, C. 2011, MNRAS, 418, 2459
- Holmberg, J., Nordström, B., & Andersen, J. 2007, A&A, 475, 519
- Karataş, Y. & Klement, R. J. 2012, New A, 17, 22
- Kiss, L. L., Moór, A., Szalai, T., et al. 2011, MNRAS, 411, 117
- Klement, R., Fuchs, B., & Rix, H.-W. 2008, ApJ, 685, 261
- Klement, R. J., Bailer-Jones, C. A. L., Fuchs, B., Rix, H.-W., & Smith, K. W. 2011, ApJ, 726, 103
- Kordopatis, G., Recio-Blanco, A., de Laverny, P., et al. 2011, A&A, 535, A106
- Matijević, G., Zwitter, T., Bienaymé, O., et al. 2012, ApJS, 200, 14
- Matijević, G., Zwitter, T., Bienaymé, O., et al. 2011, AJ, 141, 200
- Matijević, G., Zwitter, T., Munari, U., et al. 2010, AJ, 140, 184
- Munari, U., Siviero, A., Bienaymé, O., et al. 2009, A&A, 503, 511
- Munari, U., Tomasella, L., Fiorucci, M., et al. 2008, A&A, 488, 969
- Quillen, A. C. & Minchev, I. 2005, AJ, 130, 576
- Recio-Blanco, A., Bijaoui, A., & de Laverny, P. 2006, MNRAS, 370, 141
- Robin, A. C., Reylé, C., Derrière, S., & Picaud, S. 2003, A&A, 409, 523
- Ruchti, G. R., Fulbright, J. P., Wyse, R. F. G., et al. 2010, ApJ, 721, L92
- Ruchti, G. R., Fulbright, J. P., Wyse, R. F. G., et al. 2011a, ApJ, 737, 9
- Ruchti, G. R., Fulbright, J. P., Wyse, R. F. G., et al. 2011b, ApJ, 743, 107
- Sales, L. V., Helmi, A., Abadi, M. G., et al. 2009, MNRAS, 400, L61
- Seabroke, G. M., Gilmore, G., Siebert, A., et al. 2008, MNRAS, 384, 11
- Sharma, S., Bland-Hawthorn, J., Johnston, K. V., & Binney, J. 2011, ApJ, 730, 3
- Siebert, A., Bienaymé, O., Binney, J., et al. 2008, MNRAS, 391, 793
- Siebert, A., Famaey, B., Binney, J., et al. 2012, MNRAS, 425, 2335
- Siebert, A., Famaey, B., Minchev, I., et al. 2011a, MNRAS, 412, 2026
- Siebert, A., Williams, M. E. K., Siviero, A., et al. 2011b, AJ, 141, 187
- Smith, M. C., Ruchti, G. R., Helmi, A., et al. 2007, MNRAS, 379, 755
- Steinmetz, M., Zwitter, T., Siebert, A., et al. 2006, AJ, 132, 1645
- Veltz, L., Bienaymé, O., Freeman, K. C., et al. 2008, A&A, 480, 753
- Williams, M. E. K., Steinmetz, M., Sharma, S., et al. 2011, ApJ, 728, 102
- Wilson, M. L., Helmi, A., Morrison, H. L., et al. 2011, MNRAS, 413, 2235
- Wylie-de Boer, E., Freeman, K., Williams, M., et al. 2012, ApJ, 755, 35
- Zwitter, T., Matijević, G., Breddels, M. A., et al. 2010, A&A, 522, A54
- Zwitter, T., Siebert, A., Munari, U., et al. 2008, AJ, 136, 421